

Remarks/Arguments:

The Specification is amended to correct an erroneous reference to a Figure. Figure 4, referred to in the second sentence of the referenced paragraph of the application as filed as describing a thermodynamic cycle, is in fact a diagrammatic representation of a hardware system to implement an alternative embodiment of the invention of the present application. It is clear from the preceding first sentence of the referenced paragraph that the cycle diagram referred to is Figure 6.

With respect to issues raised in the Patent and Trademark Office Action of 04/03/2006:

1. Information Disclosure Statement:

The examiner correctly points out that the Information Disclosure Statement Filed March 3, 2006 did not include copies of two non-patent documents. A Supplementary Information Disclosure Statement accompanies this Amendment, with the two non-patent documents, which are in English, attached.

2. Claim Rejections under 35 USC 112:

The claims have been rewritten so that method claims recite a series of method steps, and that apparatus claims do not depend from method claims.

3. Claim Rejection under 35 USC 102:.

The rejection of Claims 1,2,4,6 and 7 as anticipated by Ranasinghe *et al* (U.S. Patent 6,347,520 B1, hereinafter the '520 patent) is respectfully traversed. In the discussion below, both the process and the apparatus disclosed and claimed in the present patent application

will be shown to be patentably distinct from the process and apparatus disclosed and claimed in the '520 patent.

The '520 patent teaches and claims two slightly different processes and apparatuses; both processes use a mixture of ammonia and water as the working fluid (WF) and operate between high pressure (HP) and low pressure (LP) in a "Rankine-style" cycle. In the following discussion, the "Preferred Winter Embodiment" will be compared and contrasted with, and distinguished from, the process disclosed in the present application.

It should be noted that the alternate "Preferred Summer Embodiment" of the '520 patent is readily distinguished from the process and apparatus of the present application, as the former incorporates two turbines, and comprises two steps of expansion of WF vapor in turbines.

The disclosed Preferred Winter Embodiment power cycle uses: (1) a feedpump; (2) a heat recovery vapor generator (HRVG) which includes (i) an economizer section, (ii) an evaporator section and (iii) a superheater section; (3) a turbine; (4) a regenerative boiler; (5) a regenerative economizer, and (6) a condenser.

The '520 process comprises the following process steps (for brevity, references to specific sections of the '520 patent will be cited by column and line numbers, abbreviated C & L):

- a) A feedpump compresses the WF liquid to form a HP liquid WF flow stream (C4L49);
- b) The economizer section of the HRVG pre-heats HP WF liquid to increase its temperature, but the WF remains in the liquid state (C5L6);

c) The regenerative economizer pre-heats HP WF liquid to increase its temperature, but again the WF remains liquid (C5L6);

d.) The liquid HP WF is split into two flows, one liquid portion entering the evaporator section of the HRVG, and a second liquid portion entering the regenerative boiler (C5L7-17);

e.) The evaporator section of the HRVG boils one flow stream of HP WF, taking it from its liquid inlet state to a vapor outlet state (C5L10-12);

f.) The regenerative boiler evaporates the second flow stream of HP WF taking it from its liquid inlet state to a vapor outlet state (C5L14-16);

g.) HP WF is recombined into a single flow stream (C5L18-19);

h.) The superheater section of the HRVG heats the combined HP WF vapor stream to well above its dew point (C5L19-23);

i.) The superheated HP WF vapor is then expanded through a turbine to extract work from the HP WF and power an electrical generator, the LP WF exiting the turbine as superheated vapor (C5L29-30);

j.) The regenerative boiler cools the LP WF vapor leaving the turbine removing sensible heat only (C5L31-34);

k.) The regenerative economizer further cools the LP WF vapor leaving the turbine and regenerative boiler, again removing sensible heat only (C5L31-34);

l.) The condenser condenses the LP WF from vapor to liquid to extract the latent heat of the WF which is taken out of the power cycle and used for district heat purposes (C5L43-46);

m.) The LP WF liquid is fed back to the feedpump (a.) to be re-pressurized thus completing the cycle.

Sensible heat refers to heat resulting from a change of temperature of a substance which does not undergo a change of state; latent heat refers to the heat resulting from a change in state of a substance, and frequently constitutes a large portion of the heat transfer during a cycle.

It should be noted that the '520 patent states that the WF is pressurized in the HRVG (C2L46, C3L2, C5L19); this would appear to be an erroneous interpretation of the operation of the disclosed process, since this is not possible in a continuous process, in which there would be little pressure differential between the feedpump and the turbine, and no pressure increase, all pressurization of the WF being done by the feed pump.

The present patent application discloses a process (which will hereinafter be referred to the Smith process) that differs significantly from the process disclosed in the '520 patent, as will be shown below. The Smith process also uses a mixture of ammonia and water as the working fluid (WF) and operates it between high pressure (HP) and low pressure (LP) in a "Rankine-style" cycle. The Smith power cycle uses (1) a feedpump; (2) a heater; (3) a turbine; (4) a recuperator; and (5) a cooler.

The Smith process comprises the following steps (references to specific sections of the present application will refer to line numbers abbreviated L, in the application as published as International Publication Number WO 2004/009964 A1):

a) The feedpump compresses the WF liquid to form a HP liquid WF flow stream (L127-128);

b.) The total flow of the HP liquid WF is fed into the recuperator (L128-129, Fig. 4, Fig. 6);

c) The recuperator extracts heat from the LP WF exit stream from the turbine to heat the HP liquid WF to its boiling point then partially vaporizes it to form a liquid/vapor mixture of HP WF, with the HP WF thereby absorbing latent heat (L132-134, Fig. 4, Fig. 6);

d.) The heater takes in the total flow of liquid/vapor mixture of HP WF, and extracts heat from the hot flue gas stream to complete the vaporization of the HP WF and superheat the HP WF vapor (L134-135, L156-157, Fig. 4, Fig. 6);

e.) The superheated HP WF vapor is then expanded through a turbine to extract work from the HP WF and power an electrical generator, the LP WF exiting the turbine as superheated vapor (L85-89, Fig. 4, Fig. 6);

f.) The recuperator cools the LP WF to its dew point then partially condenses it to form a liquid/vapor mixture of LP WF, with the LP WF thereby releasing latent heat, which is used to preheat and partially vaporize the HP WF as described in c) above, and thus keeping this latent heat within the power cycle to greatly enhance efficiency (L135-138, Fig. 4, Fig. 6);

- g.) The cooler takes in the total flow of liquid/vapor mixture of LP WF and completes condensing it to produce a LP WF liquid stream (L139-140, 156-158 Fig. 4, Fig. 6); and
- h.) LP WF liquid is fed back to the Feedpump (a.) to be re-pressurized thus completing the cycle (Fig. 4, Fig. 6).

It will be readily apparent that the Smith process differs in two significant aspects from the process disclosed and claimed in the '520 patent:

- a.) The Smith process transfers both sensible and latent heat between HP WF and LP WF in the recuperator, thereby increasing the energy retained within the cycle; the only energy lost to the cycle is that due the transfer of sensible and latent heat from the partially condensed LP WF to the cooling fluid in the cooler. This retained energy results in an increase of efficiency of the process. In contrast, in the '520 process, all of the LP WF fluid is fed to the condenser in the vapor state, so that both sensible and latent heat is transferred out of the cycle. While this loss of heat to the cycle may be acceptable if an objective of the invention is to provide district heating, as is the case in the '520 patent, it would be detrimental to operation of the Smith process, which seeks primarily to produce electricity from the burning of what would otherwise be waste biomass.
- b.) The Smith process partially vaporizes the HP WF in the recuperator before feeding it into the heater, where it is completely vaporized and superheated in the heater by the hot flue gas; the heater functions primarily as a superheater, similar in operation to an air heater. Indeed, under the process described in claim 12 the HP WF entering the heater is fully vaporized and the heater

operates completely as a superheater. In contrast, in the '520 process, fully liquid HP WF is fed into the evaporator section of the HRVG, which effectively functions as a boiler. In most jurisdictions, boiler operating conditions are legally mandated, and require specially trained, skilled, and licensed operators to be in constant attendance. See discussion at lines 43-45 and 334-344.

This is an important practical distinction, since the added capital and especially the operating costs inherent in the '520 process render the process economically impractical for small systems. The increased efficiency, simplified equipment requirements and lower operating costs resulting from the inherently safer mode of operation of the Smith process make it practical for on-site application in sawmills and other operations producing modest amounts of biomass waste.

The Smith process is also considerably simpler than the process disclosed in the '520 patent, and requires fewer components to implement. In particular, it avoids splitting and recombining the HP WF stream as described in C5L7-17. The Smith process also utilizes a simpler single-element heater instead of the three-component HRVG of the '520 patent. The Smith process, in its simplest implementation, involves only three heat-transfer steps, while the '520 process involves six such steps.

It is evident that the process disclosed and claimed in the present application differs significantly from the process disclosed and claimed in the '520 patent, and can be patentably distinguished over the '520 process. Similarly, the apparatus necessary to implement the process of the present application differs from the apparatus disclosed and claimed in the '520 patent, and can similarly be patentably distinguished over the apparatus of the '520 patent.

Application Number 10/523,135

Page 15 of 15

Response to Patent and Trademark Office Action of 04/03/2006

The claims have been amended herein to make the differences distinct. It is believed these amendments place the present application in condition for allowance.